



5...4...3...2...1...

SPACE LAUNCH SYSTEM

11/5/2015

SLS Flight Software Agile Development Process

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Space Launch System (SLS)

Safe

- Human-rated to provide safe and reliable systems
- Protecting the public, NASA workforce, high-value equipment and property, and the environment from potential harm

Affordable

- Maximum use of common elements and existing assets, infrastructure, and workforce
- Constrained budget environment
- Competitive opportunities for affordability on-ramps

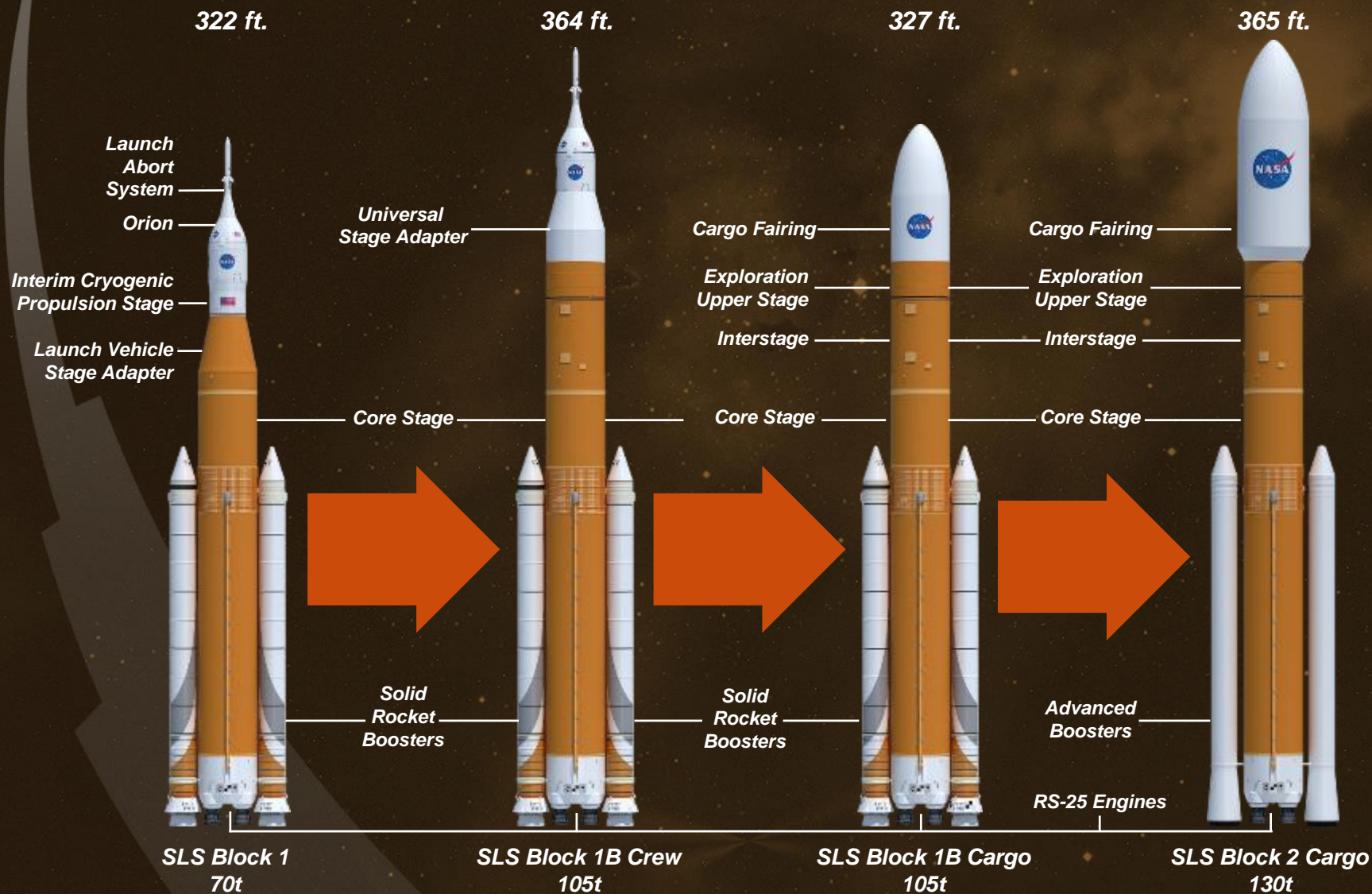
Sustainable

- Initial capability: 70 metric tons (t), 2017–2021
 - Serves as primary transportation for Orion and human exploration missions
- Evolved capability: 105 t and 130 t, post-2021
 - Offers large volume for science missions and payloads
 - Reduces trip times to get science results faster
 - Minimizes risk of radiation exposure and orbital debris impacts

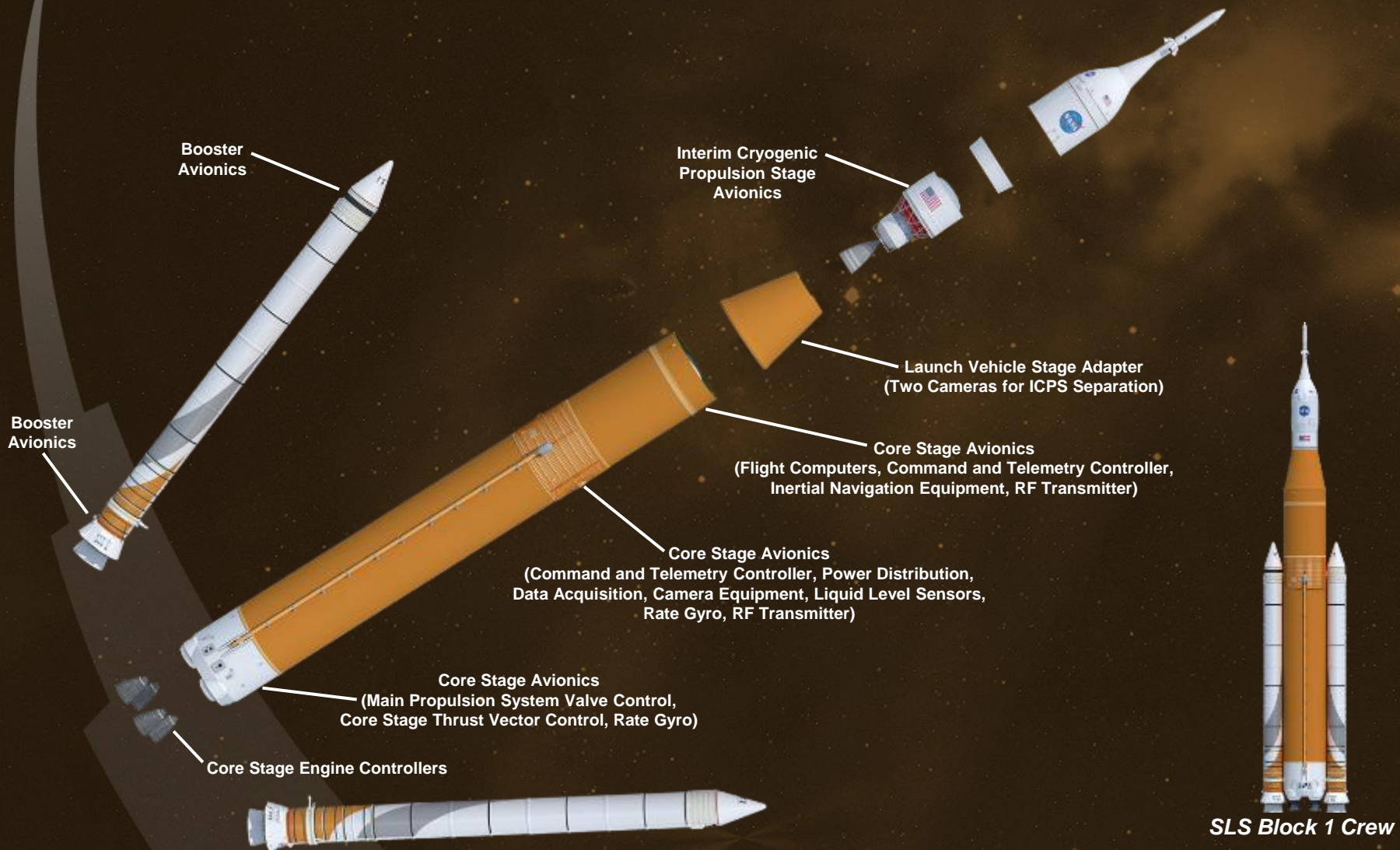


Designed for Beyond Earth Orbit Missions of National Importance

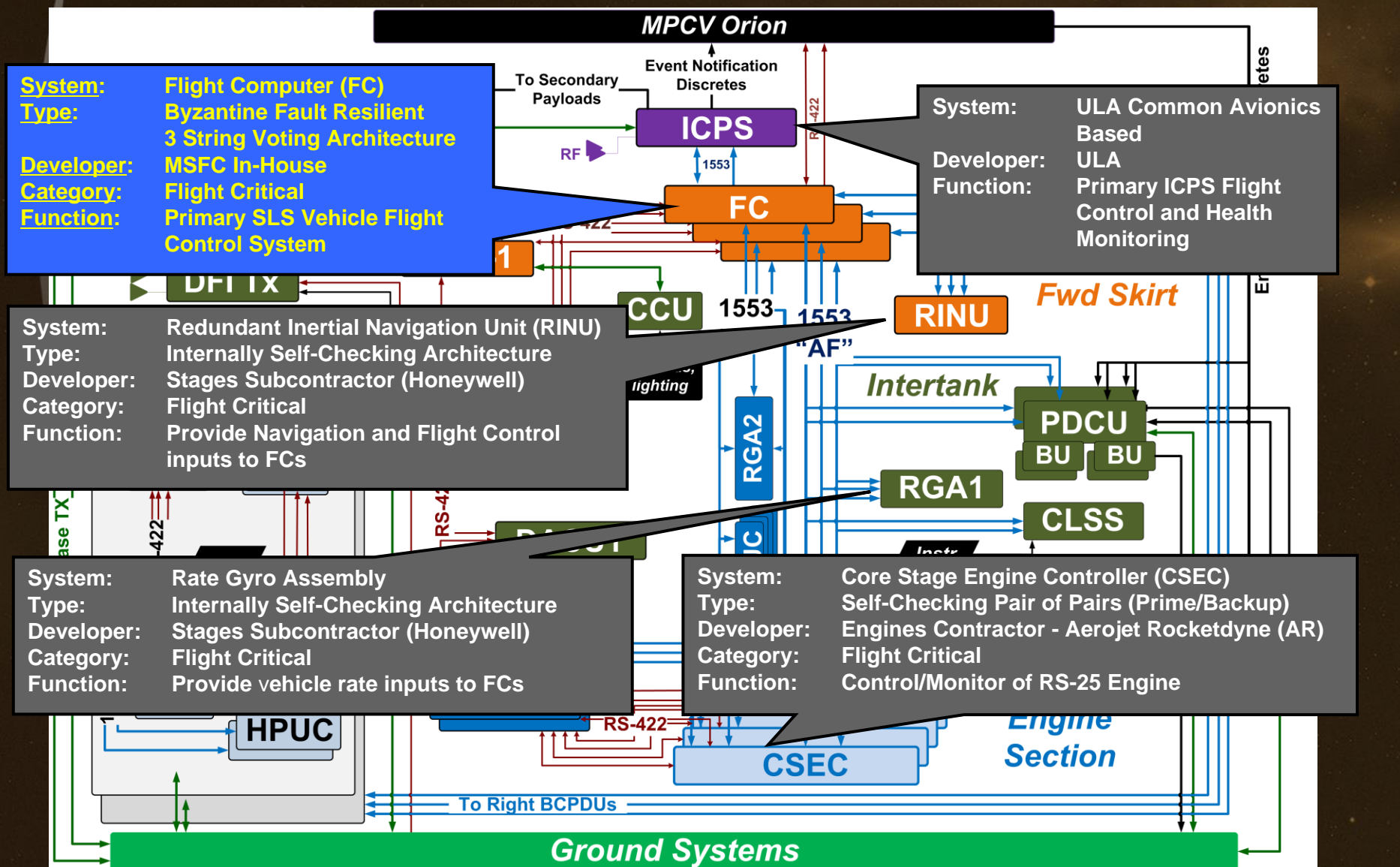
SLS Evolution Overview



Where is SLS Avionics Located?



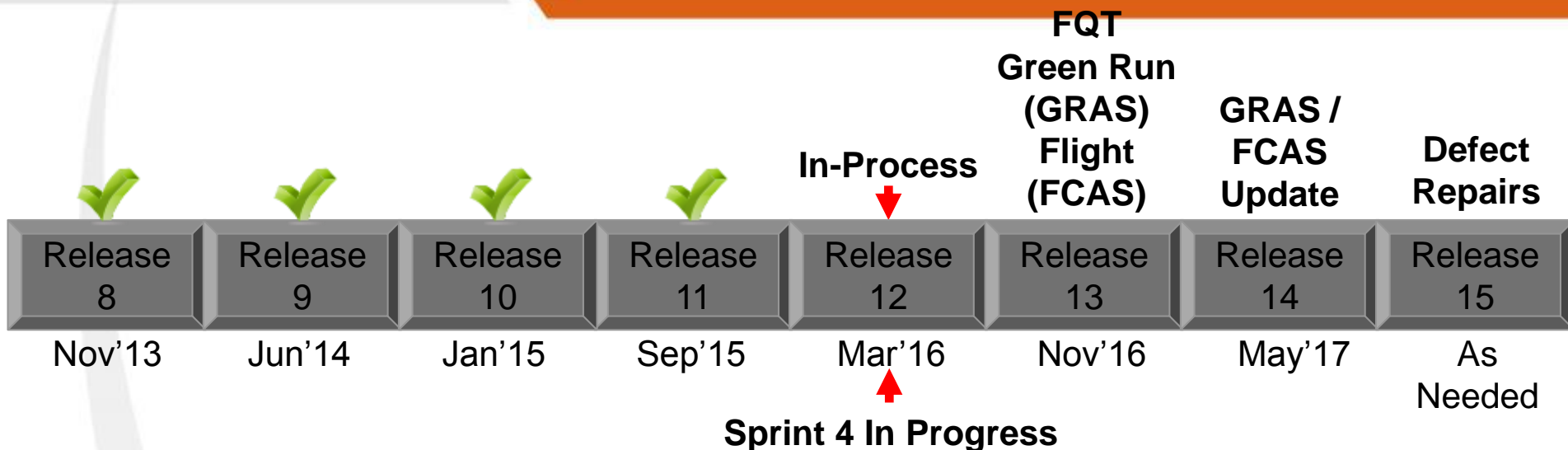
SLS Block I Software Providers



SLS CSCIs

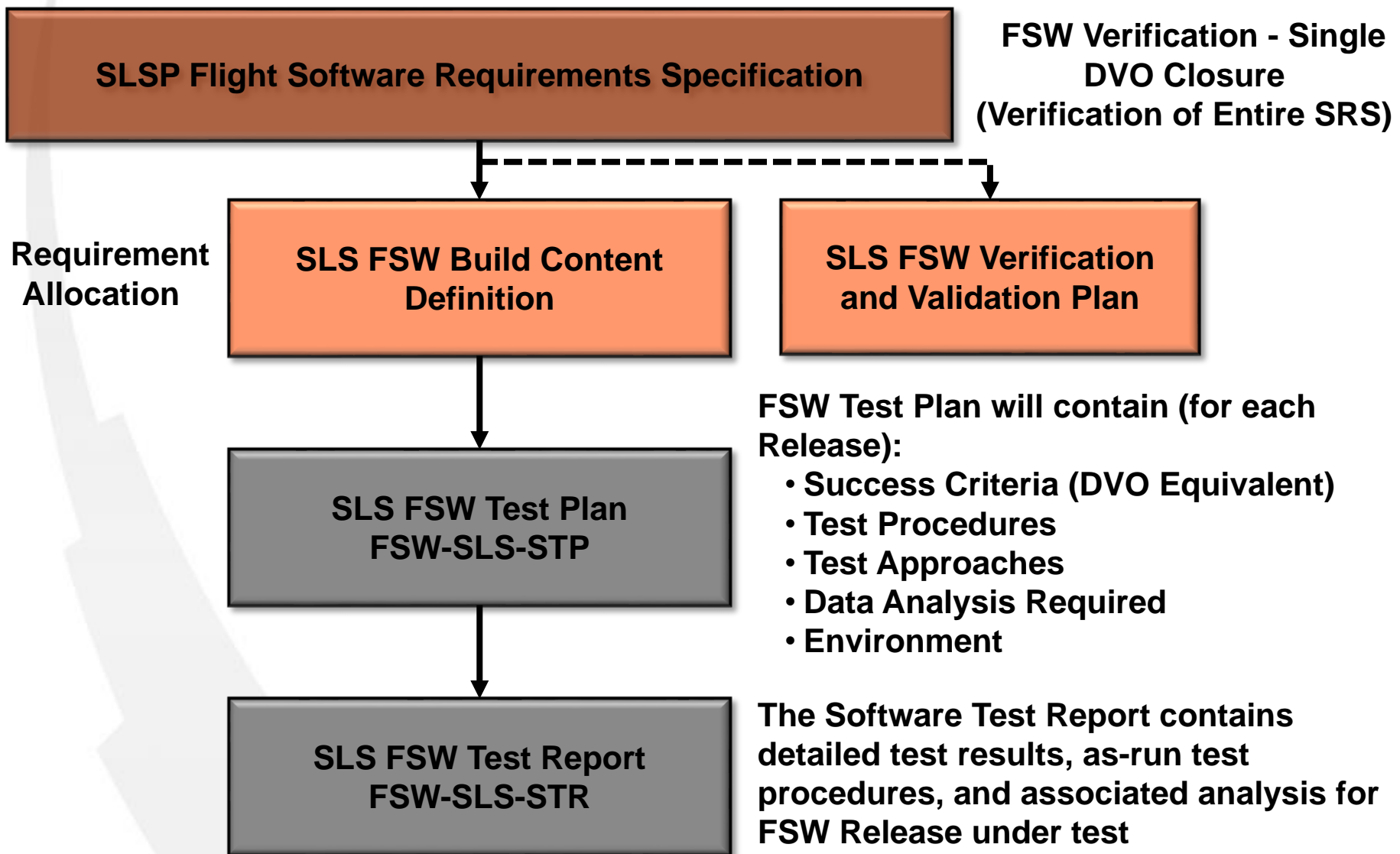
- ◆ **Flight Computer Application Software (FCAS) CSCI** is designated as Flight Computer Application Software (FCAS) and provides the flight and pre-flight critical and non-critical software functions necessary for on-pad prelaunch, launch, and ascent of the SLS vehicle
- ◆ **Green Run Application Software (GRAS) CSCI** is designated as Green Run Application Software (GRAS) and executes a pre-defined thrust vector control actuator position profile for the Core Stage (CS) Thrust Vector Controller (TVC) actuators and a pre-defined Core Stage Engine throttle position profile

Flight Software Development Approach

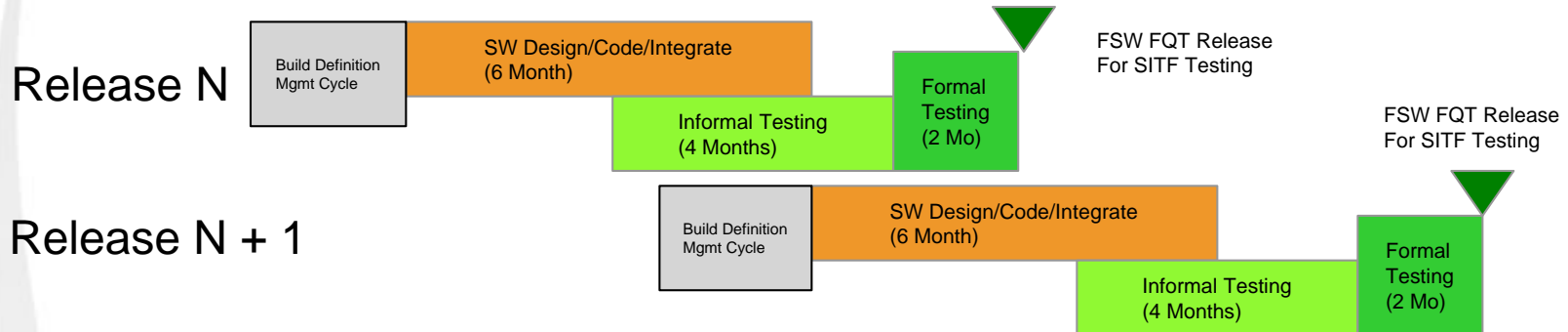


- Release 11 Delivered to End Users on 9/29/2015 (SLS ASCB Delivery Date)
 - Successful design implementation and test
- Flight Software (FSW) Release 12
 - FSW Release 12 Mission and Fault Management (M&FM) Model delivered on 5/20/2015
 - ARTEMIS 10.2b delivered for Release 12 development
 - FSW Release 12 Sprint 4 in progress
 - FSW Release 12 Test Readiness Review scheduled for 12/9/2015
- Development Approach
 - FSW Release 12 [fully functional version of both GRAS and FCAS – Engineering Release (ER) for both]
 - FSW Release 13 (initial FQT version of GRAS / FCAS)
 - FSW Release 14 (updated FQT version of GRAS / FCAS)
 - FSW Release 15 (defect repairs – as needed)

Flight Software Requirements Verification

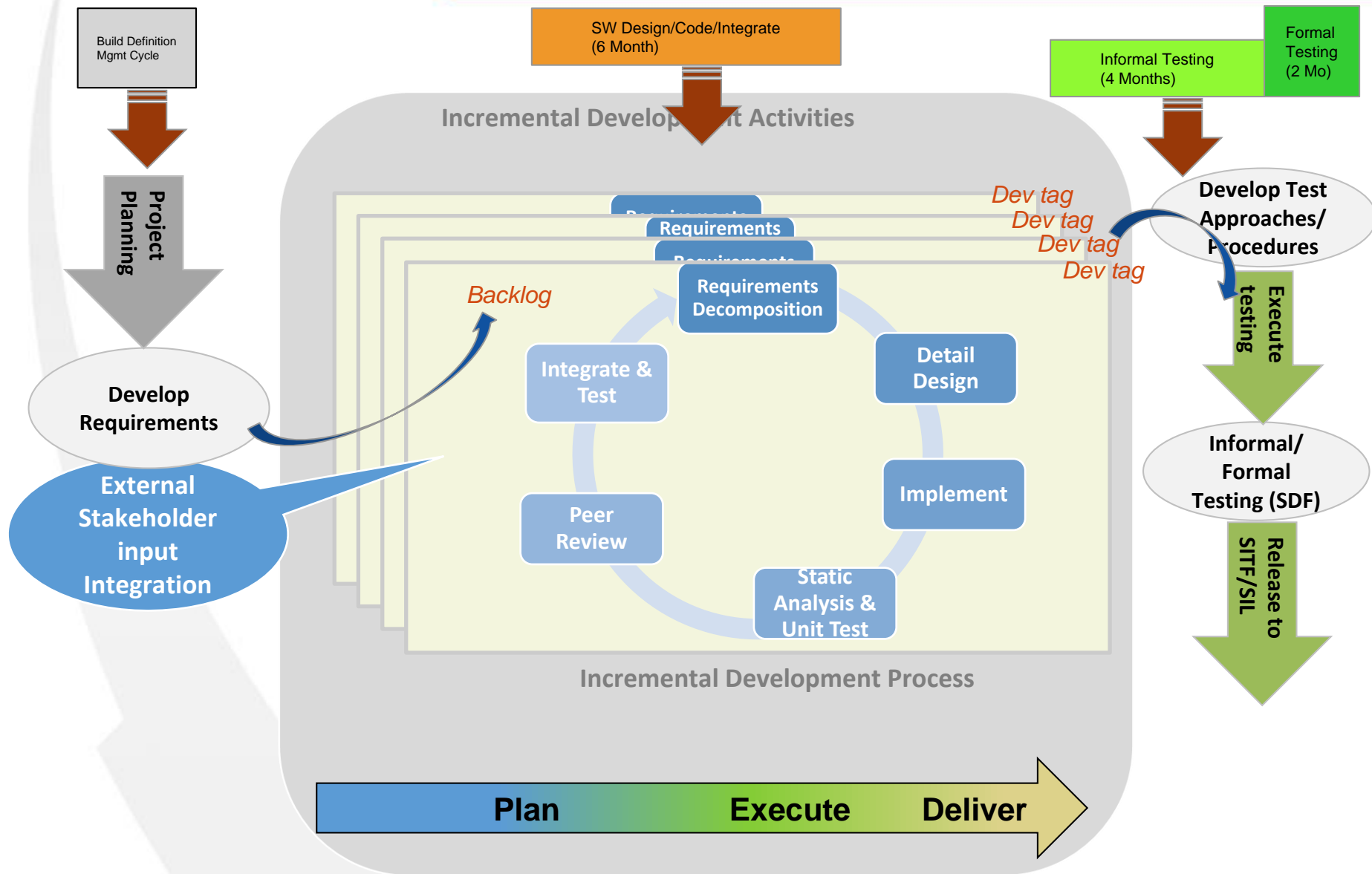


Development Process

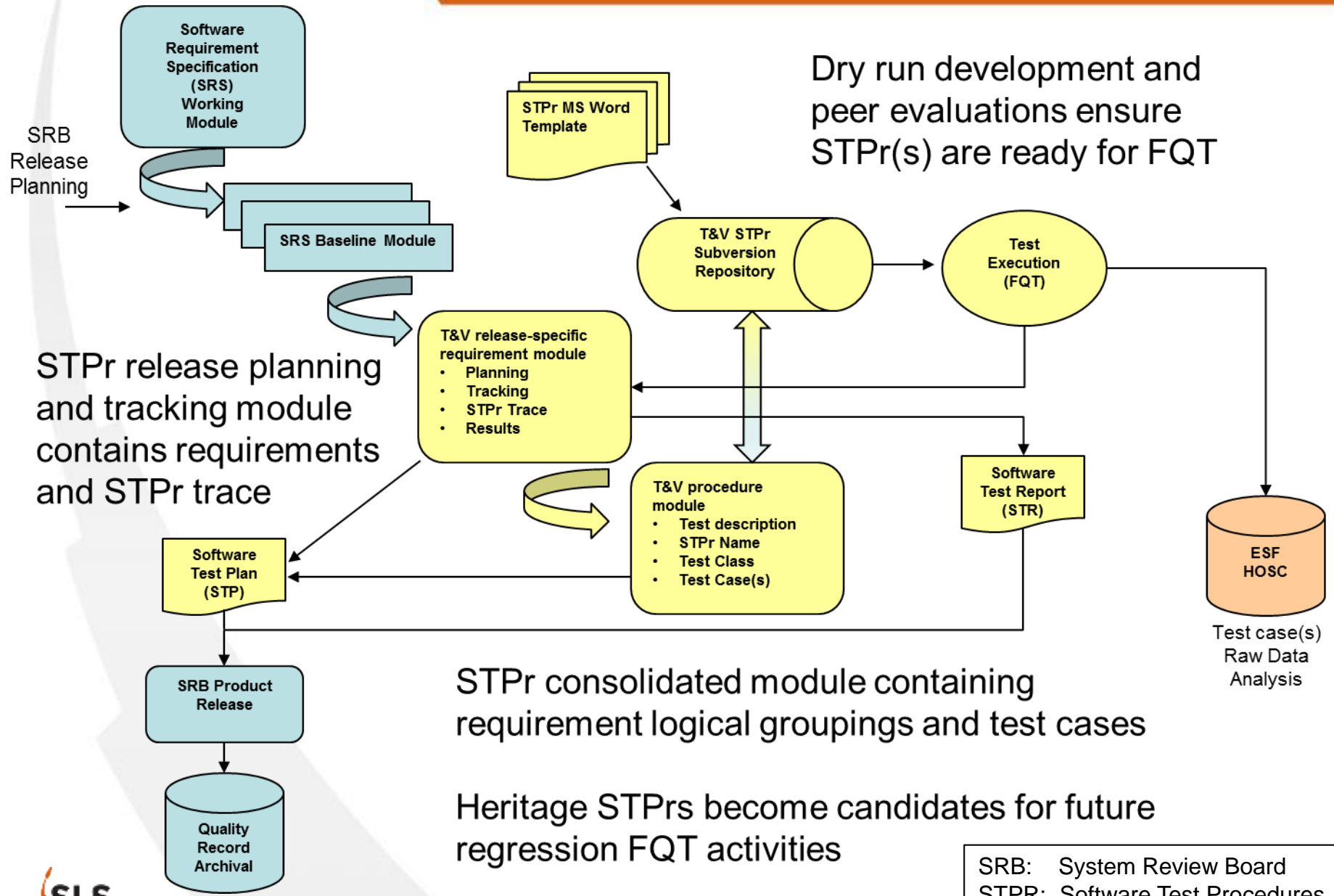


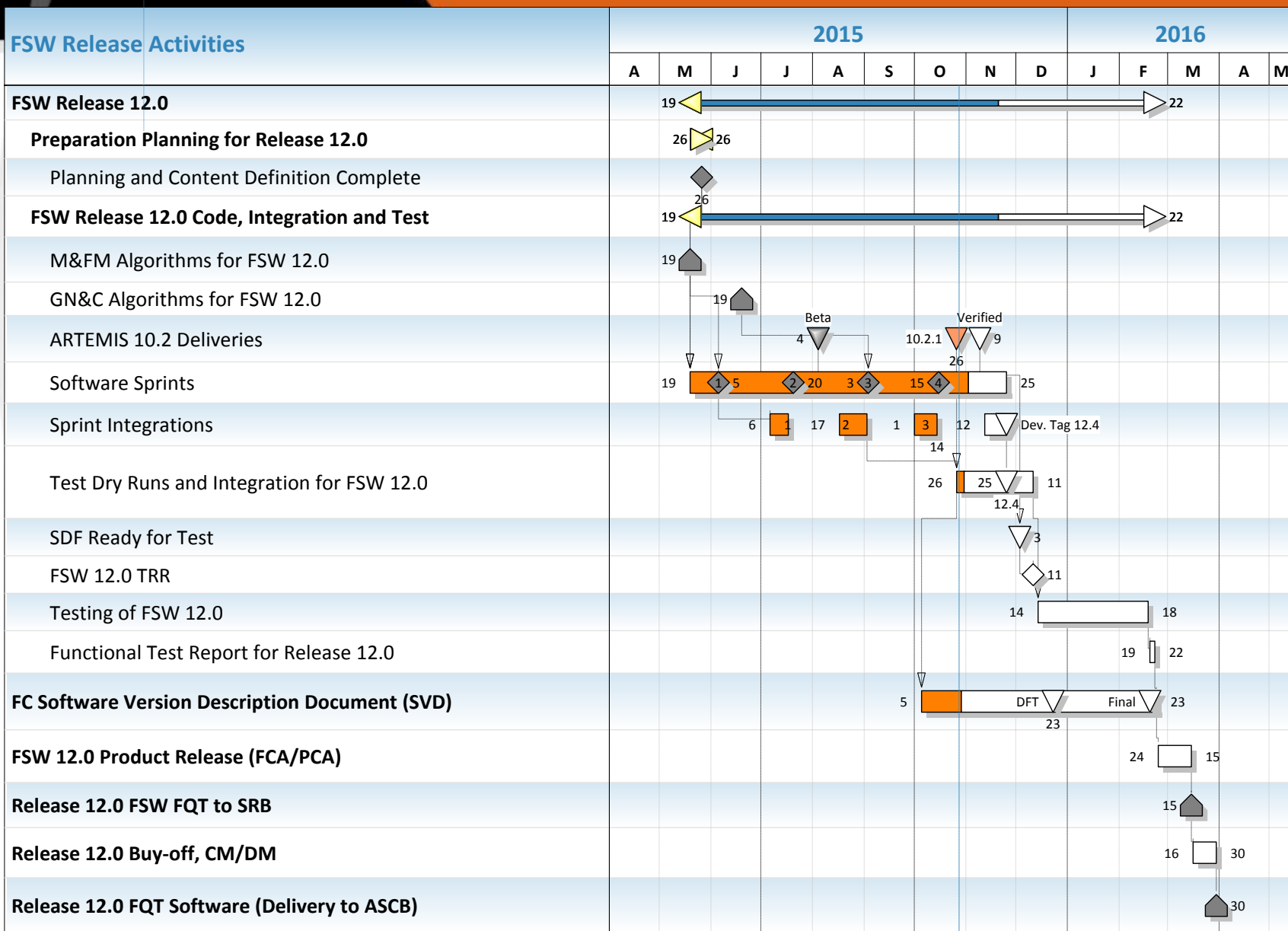
- ◆ Configuration controlled build definition/mgmt. process part of ongoing Build Definition Mgmt. Cycle. Maintained by FSW Deputy Project Lead, controlled by Level II Project Control Board
- ◆ Product content for release driven by:
 - Functional capabilities needed for release identified
 - Available source product maturity evaluated
 - Gap analysis performed between items (1) and (2)
 - Deficiencies/issues identified and addressed
 - Capability/content included in release (or provided in later release) depending upon outcome of item (4) analysis

Agile Development



SLS FSW Test & Verification



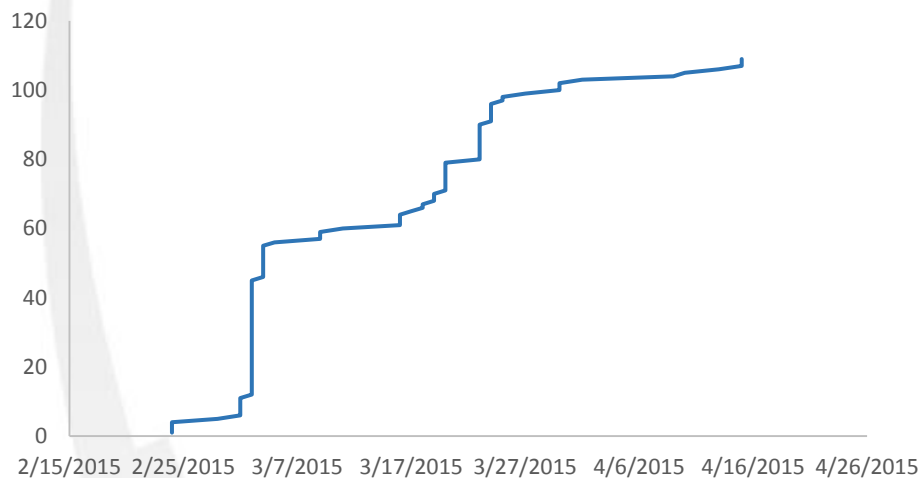


◆ Defects

- Captured in the Serena Business Manager (SBM) Change Requests (CRs) System managed by development organization.
 - Analysis for root cause performed
 - Assigned to appropriate team to resolve
 - Assigned to a release
 - Closed with release testing

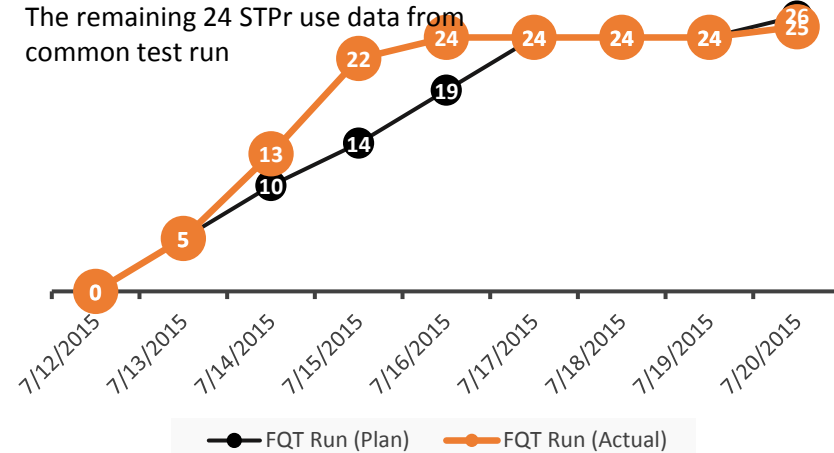
FSW Release 11 Test Results

Test Approach Development

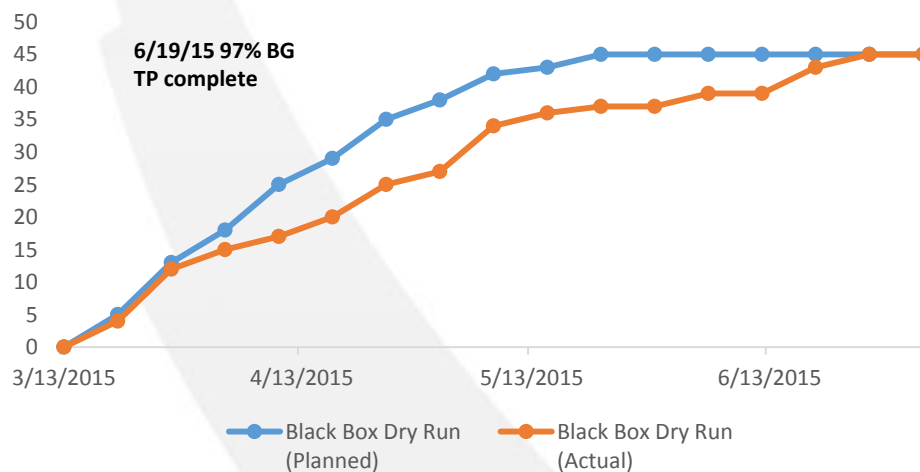


R11 FQT Execution

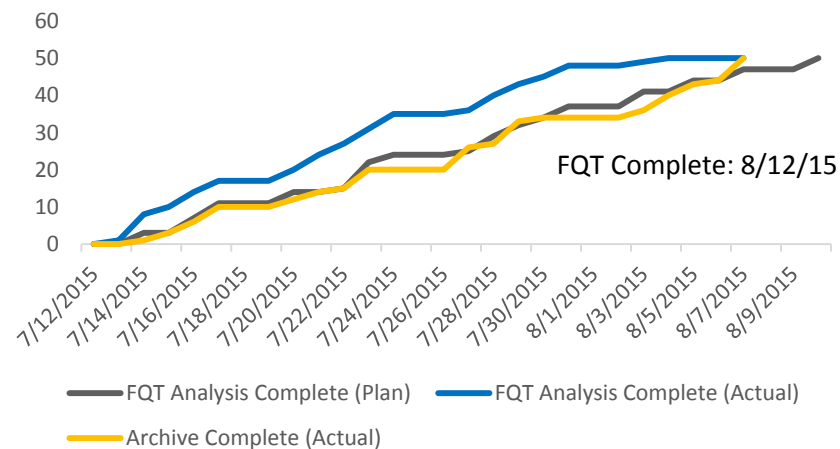
26 STPrs require unique test runs
The remaining 24 STPr use data from common test run



R11 Blackbox STPr Dry Run



R11 FQT Analysis and Archive Complete



Flight Software Maturity (R11 – R13)

Data as of 9/16/15

		Planned Maturity																Actual Maturity																								
Module/Element		R11S1	R11S2	R11S3	R11S4	R11TR	R11STF	R12S1	R12S2	R12S3	R12S4	R12TR	R12STF	R13S1	R13S2	R13S3	R13S4	R13TR	R13STF	R10S1	R10S2	R10S3	R10	R11S1	R11S2	R11S3	R11S4	R11TR	R11STF	R12S1	R12S2	R12S3	R12S4	R12TR	R12ST	R13S1	R13S2	R13S3	R13S4	R13TR	R13ST	
FCAS Modules	PLATFORM	tm	54%	62%	74%	84%	93%	93%	84%	82%	82%	82%	82%	82%	86%	88%	88%	88%	88%	100%	0%	0%	0%	54%	63%	56%	64%	63%	78%	97%	87%	81%	78%	0%	0%	0%	0%	0%	0%	0%	0%	
		cmd_proc	54%	62%	72%	80%	86%	86%	77%	80%	80%	80%	80%	80%	80%	83%	85%	87%	88%	88%	100%	0%	0%	0%	49%	64%	53%	56%	76%	84%	96%	96%	75%	75%	0%	0%	0%	0%	0%	0%	0%	0%
		rs422	54%	62%	75%	86%	96%	96%	86%	86%	86%	86%	86%	86%	86%	86%	88%	88%	88%	100%	0%	0%	0%	45%	50%	49%	54%	75%	82%	96%	96%	81%	81%	0%	0%	0%	0%	0%	0%	0%	0%	
		ssftp	35%	62%	75%	88%	100%	100%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	100%	0%	0%	0%	14%	19%	49%	60%	80%	83%	95%	95%	84%	84%	0%	0%	0%	0%	0%	0%	0%	0%
		flash	35%	62%	75%	88%	100%	100%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	100%	0%	0%	0%	14%	14%	43%	60%	67%	83%	95%	95%	85%	85%	0%	0%	0%	0%	0%	0%	0%	0%
		ibead	35%	62%	75%	86%	98%	98%	86%	86%	86%	86%	86%	86%	86%	87%	88%	88%	88%	88%	100%	0%	0%	0%	14%	16%	49%	60%	72%	82%	95%	92%	83%	83%	0%	0%	0%	0%	0%	0%	0%	0%
		tm_proc	35%	62%	73%	81%	88%	88%	81%	73%	74%	76%	79%	79%	81%	83%	85%	87%	88%	88%	100%	0%	0%	0%	14%	22%	29%	43%	71%	78%	97%	97%	78%	78%	0%	0%	0%	0%	0%	0%	0%	0%
		m1553	54%	62%	74%	83%	92%	92%	83%	83%	83%	83%	83%	83%	83%	85%	88%	88%	88%	88%	100%	0%	0%	0%	49%	72%	47%	60%	78%	81%	92%	92%	81%	81%	0%	0%	0%	0%	0%	0%	0%	0%
		ide	54%	62%	75%	78%	100%	100%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	100%	0%	0%	0%	44%	50%	52%	60%	69%	75%	85%	85%	85%	85%	0%	0%	0%	0%	0%	0%	0%	0%
		tm	35%	62%	69%	72%	72%	72%	72%	71%	74%	78%	81%	81%	82%	83%	85%	87%	88%	88%	100%	0%	0%	0%	23%	23%	45%	51%	68%	69%	69%	68%	71%	0%	0%	0%	0%	0%	0%	0%	0%	
		ode_sync	54%	62%	74%	85%	96%	96%	85%	85%	85%	85%	85%	85%	85%	86%	88%	88%	88%	88%	100%	0%	0%	0%	44%	52%	52%	59%	76%	77%	96%	86%	82%	83%	0%	0%	0%	0%	0%	0%	0%	0%
		isync	54%	62%	75%	88%	100%	100%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	100%	0%	0%	0%	46%	50%	52%	60%	74%	85%	97%	97%	85%	85%	0%	0%	0%	0%	0%	0%	0%	0%
		acd	35%	62%	69%	72%	72%	72%	72%	71%	79%	87%	88%	88%	88%	88%	88%	88%	88%	88%	100%	0%	0%	0%	18%	22%	40%	52%	69%	69%	69%	69%	69%	69%	0%	0%	0%	0%	0%	0%	0%	0%
		cwd	35%	62%	69%	72%	72%	72%	72%	72%	72%	72%	72%	72%	72%	75%	83%	88%	88%	88%	100%	0%	0%	0%	15%	18%	40%	52%	69%	69%	69%	69%	69%	69%	0%	0%	0%	0%	0%	0%	0%	0%
		cmd	35%	62%	75%	88%	100%	100%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	88%	100%	0%	0%	0%	20%	34%	55%	74%	85%	85%	97%	97%	97%	85%	0%	0%	0%	0%	0%	0%	0%	0%
		oshm	35%	62%	75%	88%	100%	100%	88%	72%	72%	72%	72%	72%	72%	72%	72%	88%	88%	100%	14%	14%	27%	27%	23%	52%	69%	69%	69%	69%	69%	69%	69%	69%	0%	0%	0%	0%	0%	0%	0%	0%
		infra	49%	62%	70%	74%	76%	76%	74%	74%	74%	74%	74%	74%	74%	76%	76%	85%	88%	88%	100%	0%	0%	0%	37%	38%	41%	45%	70%	71%	97%	97%	73%	71%	0%	0%	0%	0%	0%	0%	0%	0%
		ctc_mor	48%	48%	51%	51%	51%	51%	60%	69%	69%	69%	69%	69%	69%	74%	76%	82%	85%	88%	100%	0%	0%	0%	49%	53%	50%	50%	58%	58%	58%	58%	62%	63%	0%	0%	0%	0%	0%	0%	0%	0%
		adh_in	48%	48%	51%	51%	51%	51%	66%	65%	69%	69%	69%	69%	69%	72%	72%	72%	88%	88%	100%	49%	43%	46%	46%	49%	57%	57%	57%	57%	57%	58%	61%	0%	0%	0%	0%	0%	0%	0%	0%	
		rinu	48%	48%	51%	51%	51%	51%	60%	62%	68%	73%	76%	76%	81%	83%	85%	87%	100%	0%	0%	0%	48%	51%	54%	51%	56%	56%	56%	56%	57%	58%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
		rga	48%	48%	51%	51%	51%	51%	60%	72%	72%	72%	72%	72%	74%	76%	82%	85%	88%	100%	0%	0%	0%	44%	45%	57%	54%	54%	54%	54%	54%	58%	72%	0%	0%	0%	0%	0%	0%	0%	0%	
		cse	48%	48%	51%	51%	51%	51%	60%	62%	66%	71%	73%	73%	81%	83%	85%	87%	88%	100%	23%	24%	46%	56%	45%	45%	48%	52%	52%	52%	58%	60%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
		mpe	48%	48%	51%	51%	51%	51%	60%	66%	71%	73%	76%	76%	81%	83%	85%	87%	88%	100%	7%	7%	44%	51%	44%	44%	49%	49%	49%	49%	54%	57%	0%	0%	0%	0%	0%	0%	0%	0%		
		cs_buc	48%	48%	51%	51%	51%	51%	48%	62%	71%	73%	76%	76%	81%	83%	85%	87%	88%	100%	22%	14%	35%	41%	44%	50%	50%	50%	50%	50%	52%	54%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
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- Each cell is a measure of completeness (maturity)
- Weight sum of each major FSW process area
 - Requirements
 - Design
 - Implementation
 - Verification

low	high		
0	0.33	<33%	Low Maturity
		>34 and < 65%	Medium Maturity
0.33	0.66	>66 % and < 100%	High Maturity
0.66	0.99		
0.99	1	FQT (100%)	FQT